Vegetation

Arrowleaf balsamroot

Vegetation Overview

- Vegetation in Yellowstone is typical of the Rocky Mountains.
- Elements of the Great Plains and Great Basin floras mix with Rocky Mountain vegetation in the vicinity of Gardiner and Stephen's Creek.
- The interaction of climate and geologic substrate controls distribution of vegetation in the park.
- Disturbances—fire, floods, insects, disease—occur periodically, affecting portions of the park.
- Hydrothermal areas support unique plant communities and rare species.
- Lodgepole pine alone comprises 80% of the forest canopy.
- Six other conifer tree species: whitebark pine, Engelmann spruce, subalpine fir, Douglas-fir, Rocky Mountain juniper, limber pine.
- Deciduous trees include quaking aspen and cottonwood.
- Shrubs include common juniper, sagebrush (many species), Rocky Mountain maple.
- Wildflowers number in the hundreds.
- Three endemics—Ross' bentgrass, Yellowstone sand verbena, Yellowstone sulfur wild buckwheat *(see p. 86)*.
- More than 210 exotics.

Management

- Controlling exotics, which threaten native species, especially near developed areas; some are spreading into the backcountry.
- Surveying areas for sensitive or rare vegetation before disturbance such as constructing a new facility.

Yellowstone's vegetation is composed primarily of typical Rocky Mountain species. It is also influenced by flora of the Great Plains to the east and the Intermountain to the west. The exact plant community present in any area of the park reflects a complex interaction between many factors including the regional flora, the climate, the topography, and the local substrates/soils.

The vegetation of the park is interrelated with the geology of the park *(see Chapter 2)*. The region's caldera explosions catastrophically destroyed vegetation. In addition, glaciers significantly altered the region. Today, the roughly 1,150 native species of flowering plants in the park represent the species able to either persist in the area or recolonize after glaciers, lava flows, and other major disturbances. Unlike southwestern Wyoming or central Idaho, the Greater Yellowstone region has few endemic vascular plant species, primarily in the eastern portion of the Absaroka Mountains outside of Yellowstone. Within Yellowstone, only three endemics occur, Yellowstone sand verbena *(Abronia ammophila)*, Ross' bentgrass *(Agrostis rossiae)*, and Yellowstone sulfur wild buckwheat *(Eriogonum umbellatum var. cladophorum)*.

Major Types

Montane Forests

Forests cover roughly 80 percent of the park. Miles and miles of lodgepole pine forest characterize the park, especially within the Yellowstone Caldera. Extensive areas of forest dominated by subalpine fir and Engelmann spruce are also present, especially in areas such as the Absaroka Range that are underlain by andesites. These species can also be common in the understory where the canopy is entirely composed of lodgepole pine. Through time, in the absence of fire and in non-rhyolitic soil, subalpine fir and Engelmann spruce can replace the lodgepole pine, leading to a canopy dominated by these species. In rhyolitic soils, which are poor in nutrients needed by fir and spruce, lodgepole pine remains dominant. At higher elevations such as the Absaroka Mountains and the Washburn Range, whitebark pine becomes a significant component of the forest. In the upper subalpine zone, whitebark pine, Engelmann spruce, and subalpine fir often grow in small areas separated by subalpine meadows. Wind and dessication cause distorted forms known as krumholtz where most of the 'tree' is protected below snow.

Douglas-fir Forests

Douglas-fir forests occur at lower elevations, especially in the northern portion of the park. The thick bark of Douglas-fir trees allows them to tolerate low-intensity fire.

Finding Wetlands

Here are a few wetlands locations near roads:

Northeast Entrance Road, *beginning east of Yellowstone Picnic Area: listen for frogs in spring, look for sandhill cranes throughout the Lamar Valley*

Firehole Lake Road: *listen for frogs and look for elephant's head flowers where the road begins*

Dunraven Pass area: *look for abundant wildflowers in high elevation wetlands near the road*

Norris Geyser Basin, Back Basin: *near Puff 'n' Stuff Geyser, look for dragonflies*

All thermal areas: *look for ephydrid flies, thermophiles, and other life forms (see Chapter 4)*

Some of the trees in these forests are several hundred years old and show fire scars from a succession of low intensity ground fires. In contrast, lodgepole pine trees have very thin bark and can be killed by ground fires.

Understory Vegetation

The understory vegetation differs according to precipitation regime, the forest type, and the substrate. Lodgepole pine forest is often characterized by a very sparse understory composed mostly of elk sedge *(Carex geyeri),* or grouse whortleberry *(Vaccinium scoparium).* Pinegrass *(Calamagrostis rubescens)* occurs frequently under Douglas-fir forest but is also common under other forest types, especially where the soil is better developed or moister. In some areas of the park such as Bechler and around the edges of the northern range, a more obviously developed shrub layer is composed of species such as Utah honeysuckle *(Lonicera utahensis),* snowberry *(Symphoricarpos* spp.*),* and buffaloberry *(Shepherdia canadensis).*

Sagebrush-Steppe

This vegetation type occurs in northern range, Hayden and Pelican valleys, and Gardner's Hole. Mountain big sagebrush *(Artemisia tridentata var. vaseyana)* dominates, along with several other kinds of sagebrush. Several grass species, such as Idaho fescue *(Festuca idahoensis)*, also dominate sagebrush-steppe. The northern range can be spectacular with wildflowers in late June and early July.

Wetlands

Yellowstone's wetlands include lakes, rivers, ponds, streams, seeps, marshes, fens, wet meadows, forested wetlands, and hydrothermal pools. They occupy over 357 square miles of Yellowstone: 44 percent are lakes and ponds larger than 20 acres or having water deeper than 6.6 feet at low water; 4 percent are rivers and streams; 52 percent are shallow water systems that dry up most years. Approximately 38 percent of park's plant species—including half of the rare plants—are associated with wetlands and 11 percent grow only in wetlands. Wetlands provide essential habitat for Yellowstone's rare plants *(see page 86),* thermal species *(Chapter 4),* reptiles and amphibians *(Chapter 7),* and for numerous insects, birds and fish.

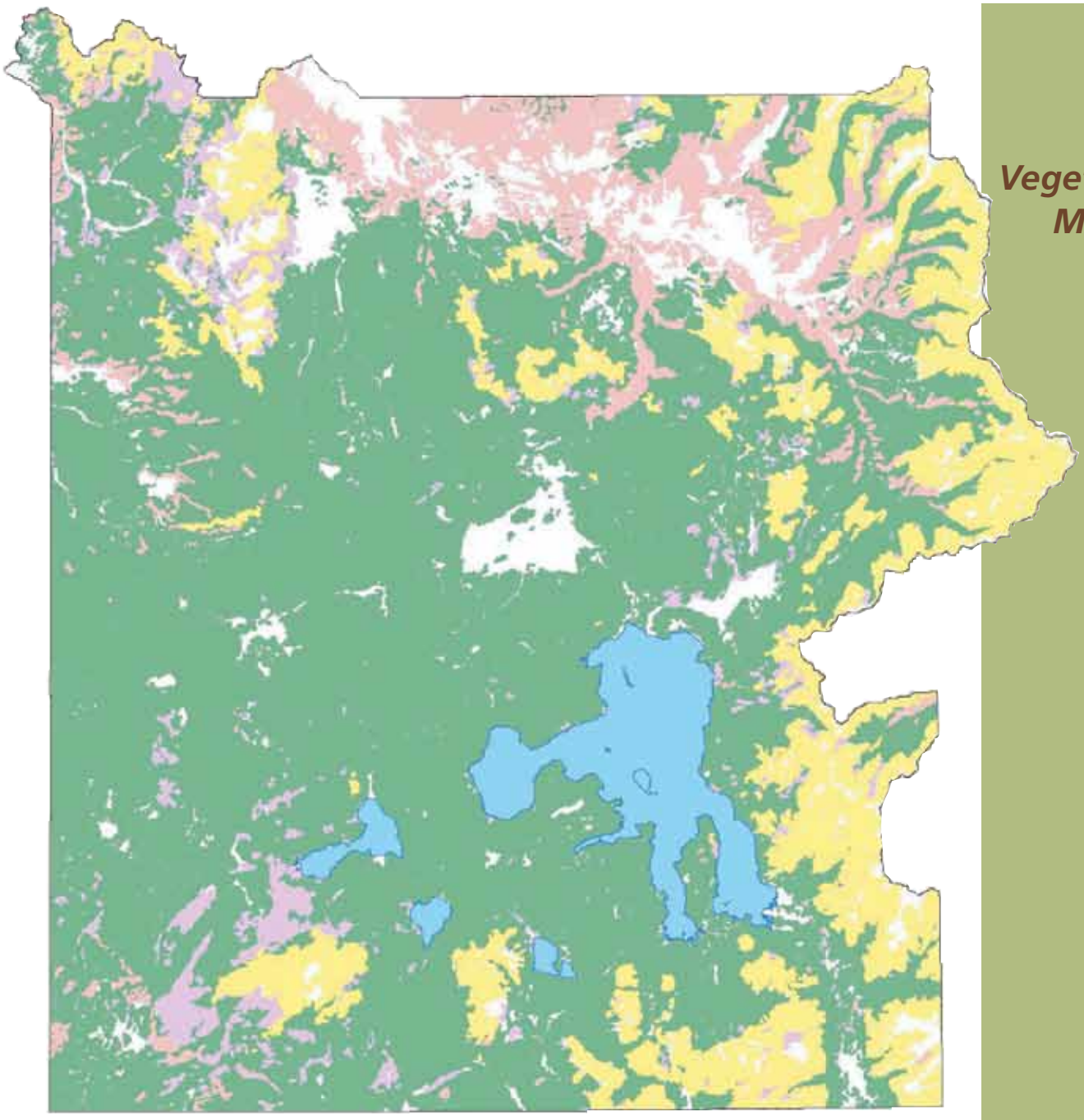
Hydrothermal Communities

Yellowstone is the best place in the world to see hydrothermal phenomenon such as geysers and hot springs. Fascinating and unique plant communities have developed in the expanses of thermally heated ground. Many of the species that occur in the geyser basins are actually species that tolerate tremendously different conditions, and thus grow all over the western United States. Other species, though, are typical of the central Rockies, or are regional endemics.

Effects of Disturbances

The park's vegetation appears at first glance to be static and unchanging, but must, in fact, respond to change. Hydrothermal plant communities demonstrate in very short periods of time that change is fundamental in any natural system. In a few days, the ground can heat up, perhaps triggered by an earthquake, and kill plants, while an adjacent area may be turning cooler, allowing plants to invade a previously inhospitable place. The vegetation of the park today reflects the effects of many different types of natural disturbance such as forest fire *(see Chapter 6),* floods, landslides, insect infestations, blowdowns, and the changing climate *(see Chapter 8, "Climate Change").*

Fringed gentian, considered the park's official flower, grows in wetlands.



Lodgepole pine forests
- Dominate more than 80% of the total park forested area.
- Can be seral (developing) or climax.
- Climax forests underlain by rhyolite.

Douglas-fir forests
- Associated with the Lamar, Yellowstone, and Madison river drainages below 7,600 feet.
- Often less than 20 inches annual precipitation.
- More frequent historic fire interval (25–60 year) than other forest types in the park.

Spruce-fir forests
- Engelmann spruce and subalpine fir dominate older forests.
- Usually found on moist and/or fertile substrates.
- Climax forests underlain by andesitic soils.

Whitebark pine forests
- Major overstory component above 8,400 feet.
- Major understory component of lodgepole-dominated forests from 7,000 to 8,400 feet.
- Seeds are ecologically important food for a variety of wildlife species.

Non-forest
- Includes grasslands, sagebrush, alpine meadows, talus, and hydrothermal environments.
- Encompasses the moisture spectrum from dry sagebrush shrublands to wet alpine meadows.
- Provides the winter and summer forage base for ungulates.

Other types not shown on map
- Aspen—found in small clones interspersed among the sagebrush/forest ecotone (transition zone) along the Yellowstone, Madison, and Snake river drainages.
- Wetland—includes various grass, forb, rush, sedge, and woody species.
- Riparian—typically streamside vegetation includes cottonwoods, willows, and various deciduous shrubs.

5

Trees

Major Types of Trees

Lodgepole pine *Pinus contorta*
- Most common tree in park
- Needles in groups of twos
- May have serotinous cones
- Up to 75 feet tall

Limber pine *P. flexilis*
- Needles in groups of five
- Young branches are flexible
- Up to 75 feet tall
- Often on calcium-rich soil

Whitebark pine *P. albicaulis*
- Grows above 7000 feet
- Needles in groups of five
- Purple-brown cones produce important food for squirrels, bears, Clark's nutcrackers
- Up to 75 feet tall

Engelmann spruce
Picea engelmannii
- Often along creeks, or wet areas
- Sharp, square needles grow singly
- Cones hang down and remain intact, with no bract between scales
- Up to 100 feet tall

Subalpine fir *Abies lasiocarpa*
- Only true fir in the park
- Blunt, flat needles
- Cones grow upright, disintegrate on tree
- Up to 100 feet tall

Douglas-fir *Pseudotsuga menziesii*
- Resembles the fir and the hemlock, hence its generic name *Pseudotsuga,* which means "false hemlock"
- Cones hang down and remain intact, with 3-pronged bract between scales
- Thick bark resists fires
- Up to 100 feet tall

Rocky Mountain juniper
Juniperus scopulorum
- Needles scale-like
- Cones are small and fleshy
- Up to 30 feet tall

Cottonwood *Populus spp.*
- Several species and hybrids
- Up to 75 feet tall
- Thick, furrowed bark
- Seeds with tangled hairs—the "cotton"— dispersed by wind

Quaking aspen
Populus tremuloides
- Sedimentary soils in damp areas
- Flexible leaf petioles quake and shiver in the breeze
- Trunks often rough and black due, in part, to browsing by elk and other animals
- Reproduces by cloning (most often), and by seeds (related to fire)

LODGEPOLE PINE

The lodgepole pine *(Pinus contorta)* is by far the most common tree in Yellowstone. Early botanical explorers first encountered the species along the West Coast where it is often contorted into a twisted tree by the wind, and thus named it *Pinus contorta var. contorta.* The Rocky Mountain variety, which grows very straight, is *Pinus contorta var. latifolia.* Various Native American tribes used this tree to make the frames of their tipis or lodges, hence the name "lodgepole" pine. Typically, lodgepole pine in Yellowstone is seldom more than 75 feet tall. The species is shade intolerant; any branches left in the shade below the canopy will wither and fall off the tree. Lodgepoles growing by themselves will often have branches all the way to the base of the trunk because sunlight can reach the whole tree.

Lodgepoles are the only pine in Yellowstone whose needles grow in groups of two. The bark is typically somewhat brown to yellowish, but a grayish-black fungus often grows on the shady parts of the bark, giving the tree a dark cast.

Like all conifers, lodgepole pines have both male and female cones. The male cones produce huge quantities of yellow pollen in June and July. This yellow pollen is often seen in pools of rainwater around the park or at the edges of lakes and ponds. The lodgepole's female cone takes two years to mature. In the first summer, the cones look like tiny, ruby-red miniature cones out near the end of the branches. The next year, after fertilization, the cone starts rapidly growing and soon becomes a conspicuous green. The female cones either open at maturity releasing the seeds, or remain closed—a condition

called serotiny—until subjected to high heat such as a forest fire. These cones remain closed and hanging on the tree for years until the right conditions allow them to open. Within a short period of time after the tree flashes into flame, the cones open up and release seeds over the blackened area, effectively dispersing seeds after forest fires. Trees without serotinous cones (like Engelmann spruce, subalpine fir, and Douglas-fir) must rely on wind, animals, or other agents to carry seeds into recently burned areas.

Lodgepole pines prefer a slightly acid soil, and will grow quickly in mineral soils disturbed by fire or by humans (such as a road cut). Their roots spread out sideways and do not extend deeply—an advantage in Yellowstone where the topsoil is only about 6 to 12 inches deep, but a disadvantage in high winds. Lodgepole pines are vulnerable in windstorms, especially individuals that are isolated or in the open.

Besides reseeding effectively after disturbance, lodgepole pines can grow in conditions ranging from very wet ground to very poor soil prevalent within the Yellowstone Caldera. This flexibility allows the species to occur in habitat that otherwise would not be forested.

Because lodgepole pines are dependent on sunny situations for seedling establishment and survival, the trees do not reproduce well until the canopy opens up significantly. In the Yellowstone region, this allows the lodgepole pine forest to be replaced by shade-loving seedlings of subalpine fir and Engelmann spruce where the soil is well-developed enough to support either of these species. In areas of nutrient poor soil, where Engelmann spruce and subalpine fir struggle, lodgepole pines will eventually be replaced by more lodgepole pine trees as the forest finally opens enough to allow young lodgepoles to become established.

Insects and Fungus Threaten the Trees of Yellowstone

The conifer trees of Yellowstone face six major insect and fungal threats. The fungus is an exotic species, but the insects are native to this ecosystem. They have been present and active in cycles, probably for centuries. A scientist studying lake cores from the park has found some of their insect remains in the cores, indicating their presence even millions of years ago. However, in the last ten years, all five insects have been extremely active, which may be due to the effects of climate change. *(See Chapter 8, "Climate Change.")*

The beetles damage trees in similar ways: their larvae and adults consume the inner bark. If the tree is girdled, it dies.

Mountain pine beetle *(Dendroctonus ponderosae)* Affects whitebark, lodgepole, and limber pine. The tree defends itself by increasing resin (pitch) production, which can "pitch out" the insect from the tree and seal the entrance to others. Look for globs of resin, often mixed with wood borings, on the bark. Adults emerge in mid-summer.

Spruce beetle *(D. rufipennis)* Affects Englemann spruce, rarely lodgepole pine. Larvae feed for two years. Look for reddish dust on the bark and at the base of the tree in early summer.

Douglas-fir beetle *(D. pseudotsugae)* Affects Douglas-fir. Larvae also consume outer bark.

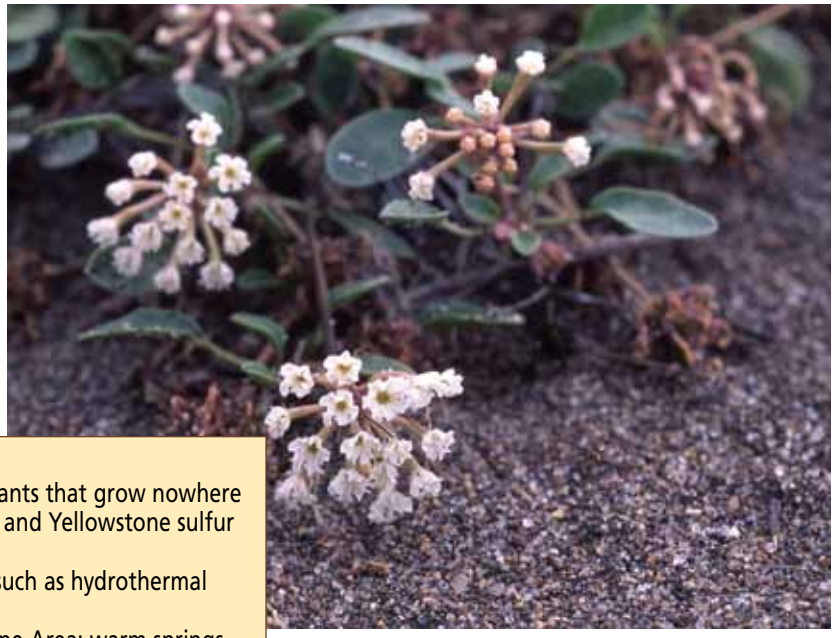
Western balsam bark beetle *(Dryocoetes confusus)* Affects subalpine fir.

Western spruce budworm *(Choristoneura occidentalis)* Affects Douglas-fir, true firs, spruce. Larvae defoliate trees and can destroy cones and seeds. Look for clumps of chewed needles on branch tips.

Blister rust is a disease caused by a fungus, *Cronartium ribicola.* Affects whitebark and limber pines. The disease impacts the tree's ability to transport nutrients and produce cones, and generally kills the tree. Look for cankers (lesions) on the bark.

5

Endemics



Only Here

- Yellowstone is home to three endemic species—plants that grow nowhere else—Ross's bentgrass, Yellowstone sand verbena, and Yellowstone sulfur wild buckwheat.
- Endemics occur in unusual or specialized habitats such as hydrothermal areas.
- Several other unusual species in Greater Yellowstone Area: warm springs spike rush, which grows in warm water; and Tweedy's rush, sometimes the only vascular plant growing in acidic hydrothermal areas.

Wildflowers

Wildflowers such as lupine and arnica often grow under the forest canopy, but the most conspicuous wildflower displays occur in open meadows and sagebrush-steppe. The appearance of spring beauties, glacier lilies, and steer's head announce spring in the park. Soon colors splash the slopes, especially on the northern range—yellow from arrowleaf balsamroot, white from phlox, reds and oranges from paintbrush, and blue from penstemon and lupine. Goldenrod and gentians indicate the coming of autumn.

Ross's Bentgrass (Agrostis rossiae)

Ross's bentgrass grows only in the geyser basins along the Firehole River and at Shoshone Lake. This species seems to require locations providing the right combination of moisture and warmth that create a natural greenhouse. The temperature within an inch of the surface under a patch of this grass is usually about 100°F. As a result, this grass is one of the first plants to green up in warm pockets of geyserite—sometimes as early as January.

Ross's bentgrass rarely grows taller than six inches and more typically only 2–3 inches. Another diagnostic characteristic of Ross's bentgrass is that the inflorescence (flower) never completely opens up. Flowers may be present in February and March, but the plants typically do not produce viable seed that early. Full bloom occurs in late May and early June. As soon as temperatures rise in the early summer, the plants dry out due to the sun's heat from above and the thermal heat from below. Ross's bentgrass is already dead and hard to find by July.

Any plant growing in thermal areas must be able to deal with constant change. A successful plant in the geyser basins must be able to shift location relatively easily as one major thermal change or several changes could eradicate the entire population. Apparently, Ross's bentgrass deals with this problem efficiently. Its seed dispersal mechanism probably includes traveling on the muddy hooves of bison and elk who inhabit thermal areas during the winter. Exotic species, such as cheat grass, pose the only known threat; as they spread in thermal areas, they eventually may outcompete Ross's bentgrass.

Yellowstone Sand Verbena (Abronia ammophila)

Yellowstone sand verbena *(photo above)* occurs along the shore of Yellowstone Lake. Taxonomists debate the relationship of this population of sand verbena to other sand verbenas. It may be distinct at the subspecific level, and is certainly reproductively isolated from the closest sand verbena populations in the Bighorn Basin of Wyoming.

Sand verbenas are a member of the four o'clock family. Very few members of the family grow this far north. Little is known about the life history of Yellowstone sand verbena. It was described as an annual in the only monograph that has examined this genus in recent years, but it is a perennial. It grows close to the sand surface. Some individuals occur near warm ground, so the thermal activity in Yellowstone may be helping this species survive. The flowers are white and the foliage is sticky, and bloom from mid-June until a killing frost.

Yellowstone Sulfur Wild Buckwheat (Eriogonum umbellatum var. cladophorum)

Several varieties of sulfur buckwheat live in the park, but this variety grows along edges of thermally influenced sites from Madison Junction to the Upper Geyser Basin. It differs from the more common varieties by the densely hairy upper surface of the leaves, and by the bright yellow of its flowers.

The full extent and impact of exotic plants in Yellowstone is unknown. Many grow in disturbed areas such as developments, road corridors, and thermal basins; they also are spreading into the backcountry. Several exotics, such as the common dandelion, have spread throughout the park.

Exotic plants can displace native plant species and change the nature of vegetation communities. These changes can profoundly effect the entire ecosystem. For example, exotics unpalatable to wildlife may replace preferred native plants, leading to changes in grazing activity. In turn, this stresses plants not adapted to grazing.

Controlling all the exotic species, some well-established, is unrealistic. The park focuses control action on species posing the most serious threat or those most likely to be controlled.

The park uses Integrated Pest Management —chemical, biological, sociological, and mechanical methods—to control some of the exotic plants. The park also cooperates with adjacent state and county Weed Control Boards to share knowledge and technology related to exotic plant detection and control.

Exotic Species
- More than 210 exotic plant species in the park.
- Resource managers target the most invasive species for control or removal.
- Species include (common names):
  Dalmation toadflax
  Spotted knapweed
  Canada thistle
  Ox-eye daisy
  Houndstongue
  Leafy spurge

Dalmatian toadflax

Dalmation toadflax *Linaria dalmatica*
- Northern portions of the park, especially around Mammoth.
- Highly invasive, replacing native plants.

Spotted knapweed *Centaurea maculosa*
- Along roadsides and in the vicinity of Mammoth.
- Aggressive species that, once established, forms a monoculture, which displaces native grasses on the ungulate winter and summer ranges.
- Aggressive control efforts underway to prevent a catastrophic change in park vegetation.

Canada thistle *Cirsium arvense*
- Throughout the park and adjacent national forests.
- Airborne seed enable it to spread widely throughout the park, invading wetlands.
- Forms dense monocultures, thus radically changing vegetation.

Ox-eye daisy *Leucanthemum vulgare*
- Mammoth and Madison areas.
- Can become dominant in meadows, is unpalatable to elk and other wildlife.
- Control efforts have substantially curtailed infestation; monitoring and evaluation continue.

Hounds tongue
Cynoglossum officinale
- Primarily Mammoth and East Entrance.
- May have been introduced by contaminated hay used by both the National Park Service and concessioners in their horse operations.
- Highly invasive.
- Seeds easily attach to the coats of animals, and thus spread along animal corridors.

Leafy spurge *Euphorbia esula*
- Small patches in Bechler and along roadsides, so far being successfully controlled but spreading actively in Paradise Valley north of the park and outside Bechler on the Caribou-Targhee National Forest.
- Becomes a monoculture, forcing out native vegetation.
- Extremely hard to control because of deep underground stems (up to 30 feet) and dense vegetation.

Restoring an Invaded Land

In 1932, President Hoover added over 7,000 acres of land to Yellowstone National Park to provide low-elevation winter wildlife habitat near Gardiner, MT. *(See Chapter 1.)* The addition included 700 acres of irrigated agricultural fields.

Park managers stopped irrigating the fields and planted an exotic perennial grass, crested wheatgrass *(Agropyron cristatum)*, that they hoped would tolerate the arid conditions and provide wildlife forage. It thrived for many decades, but was never suitable forage. Eventually another, more aggressive, non-native plant—an annual mustard, desert alyssum *(Alyssum desertorum)*—moved in. Alyssum germinates very early and uses up most of the soil moisture before other species even get started. It also exudes a chemical that inhibits soil bacteria needed by native plants.

Park managers are restoring native vegetation to this area, following recommendations of arid land restoration specialists. In 2008 and 2009, they fenced four pilot plots totaling 50 acres, where they are controlling non-native plants with herbicides and growing cover crops to increase soil organic matter and moisture-holding capacity and restore soil microbial communities. After 2 to 3 years, they will seed the plots with native species.

Managers expect the fencing to remain for 10 to 15 years while the native plants become established. The fencing prevents elk and other ungulates from grazing on the young plants.

Restoration of this area will proceed in multi-year phases to allow native plants to become established under natural conditions, to provide time for managers to monitor and refine their methods, and to provide winter wildlife habitat.

Some of these restoration plots are adjacent to the Old Yellowstone Trail, an unpaved road that parallels the Yellowstone River west of Gardiner, MT.

For More Information

www.nps.gov/yell

www.greateryellowstone-science.org/index.html

Yellowstone Science, free from the Yellowstone Center for Resources, in the Yellowstone Research Library, or online at www.nps.gov/yell

Yellowstone Today, distributed at entrance gates and visitor centers.

Site Bulletins, published as needed, provide more detailed information on park topics such as wildflowers. Free; available upon request from visitor centers.

Staff reviewers: Mary Hektner, Supervisory Vegetation Specialist; Jennifer Whipple, Botanist; Roy Renkin, Vegetation Management Specialist

Craighead, John J. et al. 1963. *A Field Guide to Rocky Mountain Wildflowers from Northern Arizona and New Mexico to British Colombia.* Boston: Houghton Mifflin.

Cronquist et al. (ongoing, currently 6 volumes) *Intermountain Flora.* New York Botanical Garden.

Despain, Don. 1990. *Yellowstone Vegetation: Consequences of Environment and History in a Natural Setting.* Boulder: Roberts Rinehart.

Dorn, Bob. 2001. *Vascular Plants of Wyoming.* 3rd edition.

Elliot, C.R. and M.M. Hektner. 2000. Wetland Resources of Yellowstone National Park. YNP: Wyoming. Out of print, available at www.nps.gov/yell

Hagle, Susan K. et al. 2003. *A Field Guide to Diseases & Insects of Northern & Central Rocky Mountain Conifers.* U.S. Forest Service Report R1-03-08. http://www.fs.fed.us/r1-r4/spf/fhp/field_guide/index.htm

Hicke, J.A. et a.. 2006. Changing temperatures influence suitability for modeled mountain pine beetle outbreaks in the western United States. *J Geophysical Research* 111:G02019.

Hitchcock & Cronquist. 1974. *Flora of the Pacific Northwest.* Seattle: UWashington Press.

Hitchcock et al. *Vascular Plants of the Northwest* (5 volumes). Seattle: UWashington Press.

Kershaw et al. 1998. *Plants of the Rocky Mountains.* Lone Pine Publishing.

Logan, J.A. et al. 2003. Assessing the impacts of global warming on forest pest dynamics. *Frontiers in Ecology and the Environment* 1:130–137.

Pauchard, A. and Alaback, P. 2006. Edge types defines alien species invasions along *P. contorta* burned, highway and clearcut forest edges. *Forest Eco. & Mgt.* 223: 327–335.

Preston, Richard J. 1968. *Rocky Mountain Trees: A Handbook of the Native Species with Plates and Distribution Maps.* New York: Dover.

Romme, William H. and Dennis Knight. 1982. Landscape diversity: The concept applied to Yellowstone National Park. *Bioscience.* 32:8.

Shaw, Richard J. 1964. *Trees and Flowering Shrubs of Yellowstone and Grand Teton National Parks.* Salt Lake City: Wheelwright Press.

Shaw, Richard J. 1992. *Wildflowers of Yellowstone and Grand Teton National Parks.* Salt Lake City: Wheelwright Press.

Sheley, Roger L. and Janet K. Petroff. 1999. *Biology and Management of Noxious Rangeland Weeds.* Corvallis: OSU Press.

Whitson, Tom L. et al. 2002. *Weeds of the West.* Western Society of Weed Science. Jackson, WY/Grand Teton Lithography.